Wetland
Studies and Solutions, Inc.

May 6, 2008

VIA EMAIL AND OVERNIGHT DELIVERY

Mr. Scott Crafton
Assistant Director
VA Department of Conservation and Recreation
203 Governor Street, Suite 302
Richmond, VA 23219

Re: Proposed SWM Methodology
WSSI #20000D

Dear Scott:

In response to discussions during our last TAC meeting, Frank Graziano (Senior Engineer at Wetland Studies and Solutions, Inc.) performed some analyses on a hypothetical 30-ac site to provide information on the implications of the various SWM methodologies that have been under discussion. This letter provides a summary of the model results, as well as a discussion on a recommended methodology.

Modeled Scenarios

As stated above, the modeling methodologies were applied to a hypothetical 30-ac site under each of the following land-use scenarios:

- Forested (CN = 60)
- Low Density Development (CN = 70)
- Medium Density Development (CN = 80)
- High Density Development (CN = 90)

The forested CN of 60 (and associated CN's for the developed conditions) represent a site in Northern Virginia – they would obviously be less in other portions of the state that have higher infiltration rates. Thus this analysis could be considered somewhat of a worst case scenario.

The SWM methodologies that were modeled in this analysis included (details are provided in the following section):

1) Conventional SWM (2 and 10-yr peak flow rate control)
2) 24-hr Detention of the 1-yr Storm

3) Energy Balance Methodology (adapted from Fairfax County PFM)

PondPack was used for both the hydrologic as well as hydraulic modeling, using NRCS methodologies. Given the desire to expedite the discussion, please note the configurations of the outlet structures were not optimized – thus the exact results could change with further refinement. Although the results are sufficiently detailed to support our conclusions and recommendations, we hope others will review and apply these recommendations to sites they have been involved with in order to test their applicability to actual sites in other geographic regions in the state.

Discussion

Results of each of the modeled scenarios are presented in *Table 1 - Summary of Model Results* at the end of this letter. Plots of the outflow hydrographs for each of the 3 modeled methodologies (vs. forested conditions) are also presented in Tabs 1-3.

Conventional SWM

As depicted in the Table 1 (columns C-N), there is a significant increase in both peak flow rate and runoff volume under each of the developed land use scenarios (as would be expected). The results of applying conventional SWM criteria (2 and 10 yr peak control) to each developed land use scenario are presented in columns O-R in Table 1 and the associated plots are presented in Tab 1. The outflow hydrographs demonstrate the degree to which the duration of the 2-yr peak flow rate increases using traditional SWM criteria. This increase can be significant, even for the low density scenario as the duration of the higher flow rates is essentially doubled for the 2-yr storm. The amount of extended duration of the peak flow rate for the less frequent 10-yr storm is not as pronounced.

24-hr Detention of the 1-yr Storm

Results of this SWM methodology are presented in columns S-V in Table 1 and the outflow hydrographs (1 and 2-yr storms) are presented in Tab 2. From the plots, application of this approach may be reasonable for low density development as the peak flow rate is significantly reduced compared to a forested condition. However, this ceases to be true as the more densely developed sites are modeled – the 1-yr flow rate meets and exceeds that of a forested condition, and with a greatly extended duration. Thus it appears from this analysis that the intended benefit of controlling this high frequency storm event is not met, particularly for higher density sites. The level of protection provided actually appears to approach that of conventional SWM as the density of the site (and associated runoff) increases.

Energy Balance

The energy balance methodology modeled in this analysis was adapted from the criteria contained in the Fairfax County Public Facilities Manual (PFM). The intent of this methodology is to account for the significant increase in runoff volume resulting from development activities by reducing the allowable peak outflow rate by a factor related to the increase in runoff volume:

$$Q_{2,d} = Q_{2,f} \times (V_f / V_d)$$

Where:

$Q_{2,d}$ = Allowable Peak Discharge for the 2-yr Storm, Developed

$Q_{2,f}$ = Peak Forested Discharge for the 2-yr Storm

V_f = Volume of Runoff, Forested Condition

V_d = Volume of Runoff, Developed Condition

The results of this analysis are presented in columns W-AB in Table 1 and in Tab 3. For this example application, the energy balance was only performed for the 2-yr event. As evident in Table 1, the outflow for the 2-yr energy balance is quite low, particularly for the higher density site. Application of the Energy Balance to the 1-yr storm event was therefore deemed unnecessary[1]. As a result, the data for the 1-yr storm depicted in Table 1 and on the plots reflects the routing of the 1-yr event through the 2-yr Energy Balance outlet structure. Likewise, the results presented for the 10-yr event reflect the matching of the peak flow rates, forested vs. developed, and not an Energy Balance of the 10-yr storm (given the infrequency of such events).

Looking at the plots, this methodology provides for lower and lower peak flow rates as the total runoff volume increases (with density of the site), ranging from about 1/2 to 1/5 of the peak forested flow rate for the low to high density developments, respectively. In this manner, the significant increase in runoff volume is offset through greatly reduced outflow rates. By limiting control of the 10-yr storm to that of conventional peak discharge rates (using "good" forested conditions as the base condition), significant channel protection can be achieved with only a modest increase in required storage volume of about 10% (in this hypothetical example) to address drainage swale/easement flooding concerns.

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[1] *Since the magnitudes of the 1 and 2-yr storms are not significantly different, we could see applying this to either event.*

Recommendation

From this analysis, the only methodology that provides for significant reductions in peak flow rates in downstream channels is the application of the Energy Balance method to the 2-yr storm event. Because of the built-in adjustability based on runoff volume, sites with significant increases in runoff volume would be required to greatly reduce the outflow rate, providing real downstream protection. However, the adjustability also provides a significant economic incentive to reduce runoff volumes using Low Impact Development (LID) techniques that reduce runoff volume through infiltration and/or evapotranspiration. The lower the runoff volume, the lower the required storage and associated costs. All of this can be achieved without a prohibitive increase in total storage volume compared to conventional 2 and 10-yr peak flow rate control.

Hopefully this analysis provides a framework for further discussion and leads to the application of this proposed methodology to "real" sites across the state. Based on this hypothetical example, it appears to be a promising option. Thank you for the opportunity to participate in the TAC and also to provide this recommendation. I look forward to further discussions.

Sincerely,

WETLAND STUDIES AND SOLUTIONS, INC.

Michael S. Rolband, P.E., P.W.S., P.W.D.
President

Encl.

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